

Hard starting every initial stage: Study on Less Engine Pulling Power

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1. Abstract:

Automobiles engine, it is a prime mover; and a machine in which power is applied to do work, often in the form of converting heat energy into mechanical work. We know that the power unit of an automobile is called I C engine. The power developed by the engine depends upon the calorific value of the fuel used. This value is equal to the total heat produced to combustion of hydrogen and carbon.

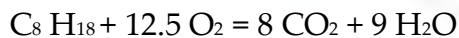
Fuel injection pump (FIP), has to supply various quantities of fuel in accordance with the different engine load and in-line pumps, which correctly positioned connects the fuel supply from gallery.

Diesel engines compress pure air during compression stroke and must have some means to force fuel into the combustion chamber with a pressure higher from the compression pressure. The injection nozzle atomizes the fuel very small droplets (3 to 30 microns) and delivers it to the combustion chamber. This achieved by small orifice.

Key Word: Atomizes, Dribbling, Injector Nozzle, Less pulling power, Orifice, Supercharging,

2. Introduction:

In diesel engines, when diesel mixed with air and burnt, it produces high temperature and pressure. This phenomenon is called combustion. For example, the chemical equation of combustion of petrol:



Incomplete combustion, result in harmful produced like CO, CO₂, NO_x etc by means of help of fuel injector in diesel engine, which spray the fuel into the cylinder of a diesel engine.

<p>HC+O H₂O and CO₂ (Complete combustion)</p>

<p>HC+O Some H₂O and Some CO₂ Some CO and Some HC (In- complete combustion)</p>
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However, Fuel Injection Pump (FIP) , the main function to deliver the fuel under pressure to the injectors and pump suppliers equal quantity of fuel at equal intervals by high pressure to the injectors , according to the engine firing order.

3. Literature Review:

Orifice means, a small round opening and it usually refers to the hole in the spray nozzle. The main purpose of a nozzle is to atomize and direct the spray of the fuel droplets into the combustion space in such a manner that proper penetration and distribution are obtained.

For example, diameter of the injector orifice to spray a fuel quantity "Q" per cycle cylinder is dt. The injection pressure is P₁ combustion chamber pressure is P₂ , density of fuel is P_f and period of injection is t second.

Pressure difference causing the fuel now through the orifice:

$$= (P_1 - P_2) \text{ Kg/cm}^2.$$

Pressure head causing the fuel flow,

$$= h_f \\ = \frac{P_1 - P_2}{\rho f} \text{ cm of Fuel}$$

Velocity of fuel through the orifice,

$$= F = \sqrt{2g - hf} \\ = \sqrt{2g \left(\frac{P_1 - P_2}{\rho f} \right)} \text{ cm/Sec.}$$

Let, cd = Coefficient of discharge of the orifice.

Q = cd × Area of the Orifice × Velocity of flow × duration of flow.

$$= cd \times \frac{\pi}{4} \times dr^2 \times v \times t$$

$$\text{Area of Orifices} = \frac{\pi}{4} dr^2$$

$$= \frac{Q}{cd.v.t} \\ = \frac{Q}{cd + \sqrt{2g \frac{P_1 - P_2}{\rho f}}} \text{ cm}^2$$

∴ Diameter of Orifice = dt,

$$= \sqrt{\frac{4Q}{\pi \cdot cd \cdot v \cdot t}} \text{ cm}$$

From the above view, Nozzle is depending on the shape of nozzle valve and nozzle orifice. The different types are – single hole; multiple; Pintle and throttle (pintaux) respectively. Single hole nozzle gives out a single spray jet and it is generally used in engine having pre-combustion chamber and such as system is known as indirect injection system using low injection pressure. Multi hole nozzles are used,

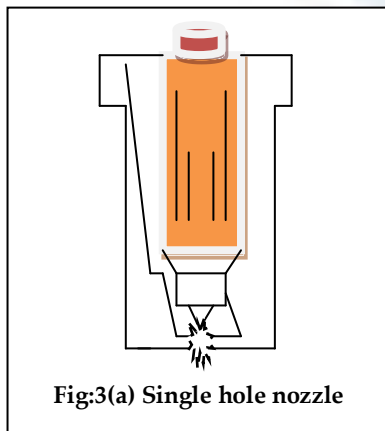


Fig:3(a) Single hole nozzle

Direct injection system and producing a highly atomized spray. Pintle nozzles are annular in shape and pressure a loosened spray. Pintaux nozzles work in two stages. A little lift of the nozzle valve supplies a small quantity of fuel during the first stage. Further lift to the nozzle valve express the fuel passage for the flow of main jet.

4. Methodology:

- 4.1. Study was completed in Tata Diesel Vehicle (LCV) that engine less pulling power.
- 4.2. Engine No: 497 SP 21 F VQ 7 438 76
- 4.3. Chassis No: 357010 C VQ 8 18215
- 4.4. Kms : 08298

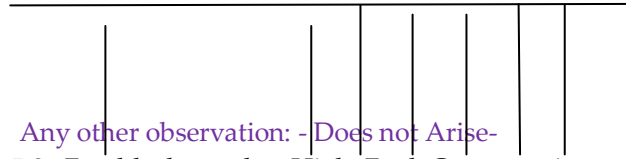
Investigation:

- 4.5. From fuel tank to FIP all connection. = Checked thoroughly one by one all parts and lubricants that no fuel line blockages.
- 4.6. Battery and self-starter: = Found OK.
- 4.7. F I P timing: = Found OK.
- 4.8. Tappet Clearance: = O.K.
- 4.9. F.I.P SL No. 36816219. = Remove FIP along with injectors, and sent for calibration to Mico Dealers, (Refit and tested the calibration and found OK).

5. Result and Discussion:

- 5.1. Product Report No. 07229 P0010
- 5.2. Engine No: 497 SP 21 F VQ 7 438 76
- 5.3. Chassis No: 357010 C VQ 8 18215
- 5.4. Fuel Injection No. 76625658
- 5.5. Governor: RSV ----- Standard.
- 5.6. Spill timing checked:
 - 5.6.1. One drop in 15 sec from swam neck.
 - 5.6.2. Comes 20° before T.D.C.
- 5.7. Injectors Checked and Found:

SL. No.	Description	1	2	3	4	5	6
1.	Opening pressure	180	182	180	180		
2.	Dribbling: y/n	No	No	No	No		
3.	Spray: OK/Blocked	G	G	P	G		
4.	Leak test- (check at 10 kg /cm ² less than Opening press ok/ leaks,	OK	OK	OK	OK		



Any other observation: - Does not Arise-
5.8. For black smoke; High Fuel Consumption, low pulling power, checked by nearest MICO dealer and the following as data for discussion.

- 5.8.1. External damages if any: **No**
- 5.8.2. Maximum Stop Screw: **Intact**
- 5.8.3. Tamper of probolts: **Intact**
- 5.8.4. Other Seals: **Intact**

5.8.5. Fuel Delivery: In as is condition

Max. Fuel delivery at 500 strokes	1	2	3	4	5	6	7
1400 rpm 1600	21.5	21.5	21.5	19.0			
900 rpm 1000	21.5	20.0	21.5	18.0			
600 rpm							

Cutting in rpm: 1650

5.9 Any other observation: - No-
5.10. Fuel Delivery: **After Rectification:**

Max. Fuel delivery at 500 strokes	1	2	3	4	5	6
1400 rpm 1600	25.0	25.0	25.0	25.0		
900 rpm 1000	27.5	27.5	27.0	26.5		
600 rpm						

Cutting in rpm: 1690

For example, determine for a four cylinder four stroke I.C. Engine, the quantity of fuel to be injected per cylinder if it consume 0.2 kg/bhp-hr and develops 500 bhp at 200 rpm, SP gravity of fuel being 0.9.

Answer:
Fuel consumption /hr: 500×0.2
 $= 100 \text{ kg.}$
And, number of cycles per hour.

$$= \frac{200}{2} \times 60$$

$$= 6000 \text{ cycles.}$$

∴ Weight of fuel per cylinder per cycle:

$$= \frac{100}{6000} \times \frac{1}{4}$$

$$= 0.00416 \text{ kg}$$

Now, specific Gravity of fuel = 0.9

Density of fuel: $0.9 \times \frac{1}{1000} = \text{kg/cc}$

∴ Quantity of fuel injected per cylinder per cycle =

$$.00416 \times \frac{1000}{0.9}$$

$$= 4.6 \text{ c.c.}$$

Supercharging that supplying of combustion air, to the engine at higher than the atmosphere pressure, usually 2 to 4 psig and in some engines up to 30 psig., the ratio of actual charge drawn into the displacement volume of the piston is called the volumetric efficiency. With supercharging, however, due to higher pressure, the density of the charge increases and therefore, its weight per stroke is increased for the swept volume. It is seen that the power output of an engine is almost directly proportional to the weight of charge per minute. Therefore, the super charged engine gives more output.

In terms of, power requirement, a super charger driven by the engine consumes considerable energy and the power required is estimated by the following equation:

Work done per kg of air per stage:

$$W = \frac{n}{n-1} [P_2V_2 - P_1V_1]$$

$$W = \frac{n}{n-1} P_1V_1$$

$$= \left[\left(\frac{P_2}{P_1} \right)^{n-1/n} - 1 \right]$$

$$= \frac{n}{n-1} RT_1$$

$$= \left[\left(\frac{P_2}{P_1} \right)^{n-1/n} - 1 \right]$$

However, super chargers are air compressor driven either engine shaft or by exhaust gas turbines.

View for going, as example that the fuel in the pump barrel, before the commencement of the effective stroke is 6.5 cc. The fuel line from the

pressure (100 – 200 kg/cm²) and atomized after spray form. The air is expelled from the fuel supply systems by loosening the two vent plugs situated on top of the governor housing and then hand priming the fuel feed pump. The following as data of FIP in Tata Diesel Vehicle:

6.5. Fuel Injection Pump:

P.I S 6 A 95 D 410 R S 2712, (Idling unit – Lever and high pressure injection type.)

6.6. Combination No:

9 400 030 564 (R.Q.B. – Full rated)
9 400 030 563 (R.Q.B – De-rated)
9 400 030 579 (R.S.B – Full rated)
9 400 030 578 (R.S.B – De-rated)

6.7. Governor:

R.Q.B 300 – 1400 SB 1243 L
R.S.B 300 – 1400 A 2 B 1160 L

6.8. Nozzle:

D L L A 142 S 1142
9 430 034 284

6.9. Feed Pump:

F.P./K.E. 22 A.D.310
9 440 030 028

6.10. High Pressure Injection System:

(Advantages of 692 TDV)

6.10.1. Element diameter of F.I.P. is increased from 8 mm to 9.5 mm.

6.10.2. Fuel injection thread diameter of nozzle is decreased from 0.31 mm to 0.27 mm.

6.10.3. Integrated Lubrication system (towards proper function of cam shaft) improved, etc.

7. Conclusion:

Attention has been drawn into the gasoline direct injection (GDI) engine due to various potential advantages. GDI engine provide various advantages, including precise control of fuel injection to each cylinder in each cycle and the capability of producing stratified charge lean – burn combustion with fully un-throttled operation. Especially, viable one GDI engines that have been introduced since 1996, which have overcome problems of earlier GDI system based on diesel – injection systems will advanced – computer- controlled fuel injection system. In

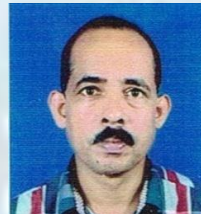
cylinder direct injection of fuel allows two different combustion strategies to be used:

7.1. The simplest method is to produce a homogenous charge by injecting the fuel during the intake stroke to allow enough time for fuel vaporization and mixing. Load Control is achieved via throttling.

7.2. Direct injection stratified –charge (DISC) engines, in which compact fuel rich clouds is formed around the spark plug in an overall lean mixture. Spark ignition is used to intake combustion both GDI strategies and can be adjusted for various engine speeds and loads by a computer based control system. The full potential of the GDI combustion systems requires use of both GDI strategies.

Therefore, exist a significant improvement in engine performance and emissions characteristics operating automatic control as compared to the manual control of the systems throughout the range of engine operating parameters.

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9. Biographies

The author as Engineering Graduate, PGDBM along with Ph.D. in Automobile Engineering from International University, Washington, USA/2001 and Published more than 170 research papers in National/International conference and international on-line journals.

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